



Simultaneous radio to mm monitoring of potential GLAST blazars

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Multi-wavelength (MW) activities: the 'low energy' part

- ✓ GLAST will provide tremendous opportunity for future blazar studies

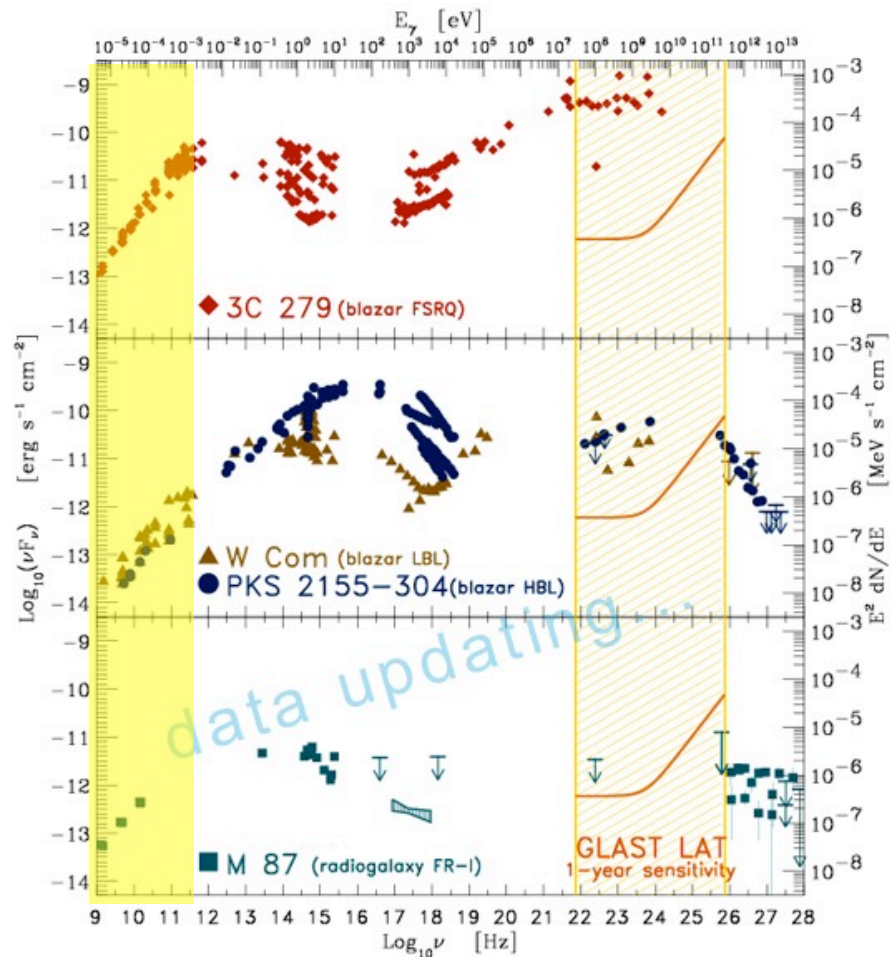
- ✓ maximum science return from the offered LAT capabilities: MW studies

➔ **MW campaigns:** ToO/Trigger, Intensive Planned Campaigns (PICs, months) and planned long-term campaigns (> 1 year)

- ✓ campaigns include optical, RXTE, Chandra, INTEGRAL, Spitzer etc.

- ✓ cm / mm / sub-mm regime: 'low-energy' synchrotron part of blazar SEDs

➔ **Comprehensive, complementary observations in the radio bands**





Effelsberg monitoring at cm/mm bands

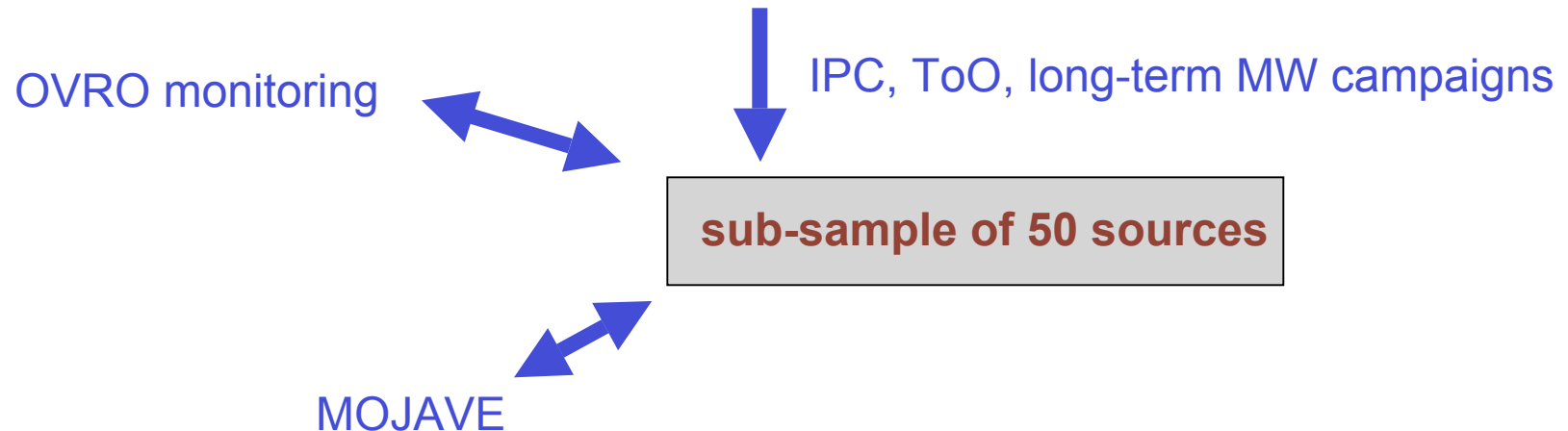
- ✓ OVRO monitoring (T. Readhead previous talk)
 - ✓ GLAST dedicated flux density and polarisation monitoring of a larger sub-sample of potential GLAST blazars
 - ✓ **Aim:** (quasi-) simultaneous broad band spectra and variability data (cm, mm, sub-mm, IR / optical)
 - ✓ Effelsberg 100m telescope:
 - ✓ good and broad frequency coverage between 21cm and 7mm
 - ✓ full polarisation information
 - ✓ fast frequency switching capabilities (sec.) in the secondary/primary focus
 - ✓ good sensitivity (new sub-reflector in 2006)
- ➔ high-precision, (quasi-) simultaneous broad band spectra in about 30 min ($\sim 0.5 - 1$ Jy source, 1 to a few percent accuracy)





Effelsberg monitoring at cm / mm bands

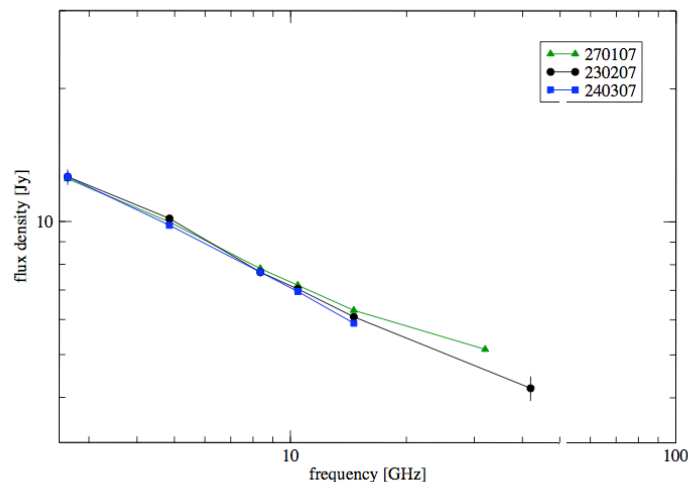
- ✓ first epochs of ~36 hrs end of January, February, March 2007 at 110, 60, 36, 28, 20, 13, 9, 7mm
- ✓ sampling aim: 1 epoch every ~ 3 - 4 weeks over the next years
- ✓ source sample selection: 'high priority VIP' AGN/blazar list of the LAT AGN group of 150 sources



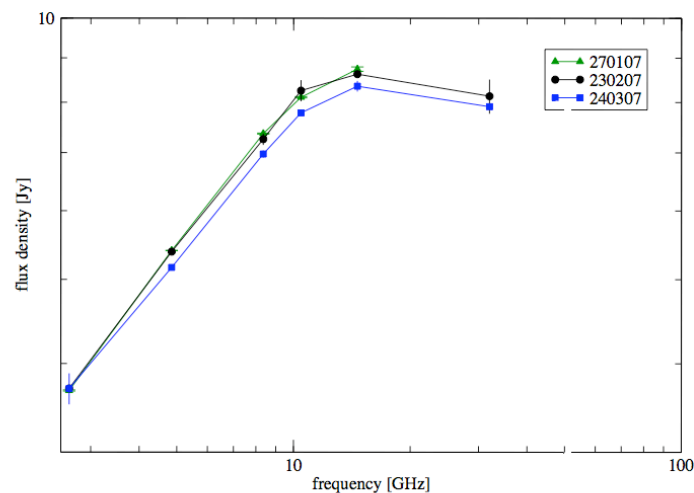


Effelsberg monitoring at cm-/mm-bands

3C454.3



NRAO150



Source	RA	DEC	$S_{3mm}(Jy)$	Source	RA	DEC	$S_{3mm}(Jy)$
0003-066	00:06:13	-06:23:35	0.65	1156+295	11:59:32	+29:14:44	0.49
0059+581	01:02:45	+58:24:11	1.42	1219+285,WCom	12:21:32	+28:13:59	0.36
PKS0215+015	02:17:49	+01:44:50	0.86	1226+023,3C273	12:29:07	+02:03:09	12.73
3C66A,0219+428	02:22:40	+43:02:08		M87	12:30:49	+12:23:28	
0234+285,4C28.07	02:37:52	+28:48:09	2.31	1253-055,3C279	12:56:11	-05:47:22	29.71
0235+164	02:38:39	+16:36:59	1.57	1308+326,OP313	13:10:29	+32:20:44	1.67
NGG 1052	02:41:05	-08:15:21	0.76	PKS1406-076	14:08:56	-07:52:27	0.58
0300+470,4C47.08	03:03:35	+47:16:16	0.72	H1426+428	14:28:33	+42:40:21	
3C84	03:19:48	+41:30:42	3.92	PKS1510-08	15:12:51	-09:05:60	1.21
0317+185	03:19:52	+18:45:34		1ES1544+820	15:40:16	+81:55:06	
OE355	03:36:30	+32:18:29	1.64	1633+382,4C38.41	16:35:15	+38:08:05	3.44
0415+37,3C111	04:18:21	+38:01:35	1.96	1641+399,3C345	16:42:59	+39:48:37	3.74
3C120	04:33:11	+05:21:16	1.50	1652+398,Mkn501	16:53:52	+39:45:37	0.69
1ES0502+675	05:07:56	+67:37:24		NRAO 530	17:33:03	-13:04:50	2.27
PKS0528+134	05:30:56	+13:31:55	7.69	1807+698,3C371	18:06:51	+69:49:28	1.33
S50716+71	07:21:53	+71:20:36		1823+568,4C56.27	18:24:07	+56:51:01	1.52
PKS0735+17	07:38:07	+17:42:19	0.80	CygA	19:59:28	+40:44:02	
0748+126	07:50:52	+12:31:04	2.15	1ES1959+650	19:59:60	+65:08:55	
TXS0814+425	08:18:16	+42:22:45	0.64	PKS2155-152	21:58:06	-15:01:09	1.68
0827+243,OJ248	08:30:52	+24:10:60	0.79	2200+420,BLLac	22:02:43	+42:16:40	2.91
S50836+71	08:41:24	+70:53:42	1.32	4C31.63	22:03:15	+31:45:38	1.26
0851+202,OJ287	08:54:49	+20:06:31	7.30	CTA102,OY150	22:32:36	+11:43:51	6.00
S40954+65	09:58:47	+65:33:55		2251+158,3C454.3	22:53:58	+16:08:54	3.31
PKS1038+064	10:41:17	+06:10:17	0.72	1ES2344+514	23:47:05	+51:42:18	
1101+384,Mkn421	11:04:27	+38:12:32	0.43	PKS2345-16	23:48:03	-16:31:12	1.62
1133+704,Mkn180	11:36:26	+70:09:27					



Towards the short mm bands

- ✓ **aim:** extension of the Effelsberg monitoring towards the (shorter) mm band (3 and 1 mm)

➔ IRAM telescope: Pico Veleta 30m

- ✓ sensitive heterodyne receivers at 3 and 1 mm simultaneously
- ✓ flux-density plus polarisation
- ✓ proposal submitted for a coordinated, (quasi-) simultaneous monitoring at IRAM (Ungerechts et al.) and Effelsberg (March 2007)





Outlook I

- ✓ add the IR / optical bands
 - ✓ (quasi-) simultaneous optical observations with the 1.2m Kryoneri telescope approved (V/B/R/I bands)
 - ✓ REM & AIT telescopes (approved, V/R/I/H bands)
- ✓ increase the total number of sources (OVRO, MOJAVE, GLAST sources)
- ✓ towards the sub-mm bands (0.8 mm): e.g. the SMA - Submillimeter Array
- ✓ implement ToO strategy
- ✓ mm-VLBI monitoring (VLBA, GMVA)



Outlook II - science

1. Variability studies and spectral evolution in the radio bands (cm- to (sub-) mm):

- ✓ frequency dependent variability (I & P) studies including e.g. correlations, time lags, duty cycles etc. in comparison with variability models, var. Doppler factors
- ✓ first time systematic study of I and P variability at cm- and mm-bands
- ✓ study of simultaneous radio spectra and their evolution (spectral indices, turnover etc.) in comparison with synchrotron/variability models
- ✓ polarisation: magnetic field, rotation measure

2. VLBI related studies:

- ✓ combination with quasi-simultaneous VLBI data (MOJAVE, GMVA)
- ✓ relate the observed VLBI structure & jet kinematics to the single-dish flux density, spectral variability and Doppler factors
- ✓ identify the jet regions responsible for the cm/mm variability
- ✓ flare-ejection relation, etc.



Outlook II - science

3. broad-band studies in the GLAST era

- ✓ complements the future GLAST MW activities of the LAT AGN group
- ✓ variability studies across all bands (correlations, time lags etc.) in particular: GLAST data
- ✓ discriminate between geometrical and radiation induced variability
- ✓ e.g. time-resolved, quasi-simultaneous broad band (radio to gamma) spectra, test/modeling of jet emission models
- ✓ combination with VLBI: identify the jet regions responsible for the gamma-ray emission, gamma-flare-ejection relation etc.



Summary

- ✓ new, coordinated broad band monitoring campaign
 - ✓ ambitious effort to study the radio variability of a larger sub-sample of potential GLAST blazars
 - ✓ cm/mm efforts complement the MW activities/campaigns of the LAT AGN group and together with all the other existing programs:
- ➔ huge broad band data base to study & understand the high energy emission recorded by **GLAST**